Final Report

Capsize
of Barge CB100-01 towed by ASL Osprey
off the Indian Coast
on 7 July 2022

TIB/MAI/CAS.128

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

28 June 2023

The Transport Safety Investigation Bureau of Singapore

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ABBREVIATIONS

AHT	Anchor Handling Tug
DGST	Directorate General of Sea Transportation, Indonesia[1]
DPR	Daily Progress Report
GRT	Gross Registered Tonnage
H	Hour
km	Kilometres
knots	Nautical mile per hour
m	Metres
mm	Millimetres
MRCC	Maritime Rescue Coordination Centre
MT / T	Metric tonnes / Tonnes
MWS	Marine Warranty Survey
nm	Nautical mile
OOW	Officer Of the Watch
OPL	Outside Port Limits
P&I	Protection and Indemnity insurance[2]
RINA	RINA Services S.p.A.
UTC[3]	Universal Coordinated Time

[1] Maritime Administration, Republic of Indonesia.
[2] Mutual maritime insurance provided by a P&I Club.
[3] Coordinated Universal Time (UTC) is the primary time standard to which the world regulates clocks and time.

SYNOPSIS

On 7 July 2022, when the Singapore registered tug ASL Osprey was towing the barge, CB100-01, on a voyage from Singapore to Djibouti, the towing pennant wire rope parted causing the barge to drift, when the vessels were in the Arabian Sea. A reconnection was made to tow the barge towards Mumbai. However, during the subsequent voyage, the barge capsized and presumed to have sunk. The barge was discovered at the Palshet beach on the Indian west coast, about 240nm away from the location of capsize.

The Transport Safety Investigation Bureau classified the occurrence as a very serious marine casualty.

The investigation revealed the following key findings:

a. for unknown reasons, the Master of ASL Osprey had deviated from the planned route as recommended in the Towing Manual, taking the tug and tow into deteriorating weather conditions.

b. the main towline and towing pennant wire rope were of a different lay and the towing arrangements were subject to tension and strain during various legs of the voyage due to the weather experienced. The Master of ASL Osprey did not pay out the towline to reduce the tension on the towing arrangements. As a result, the towing pennant wire rope weakened and eventually parted when the tug and tow encountered heavy weather.

c. during the attempt to reconnect the barge to ASL Osprey, the hull of the barge was breached by the ASL Osprey causing seawater ingress which affected the watertight integrity.

d. the towing equipment had not been inspected and maintained as per established procedures.

VIEW OF VESSEL 1

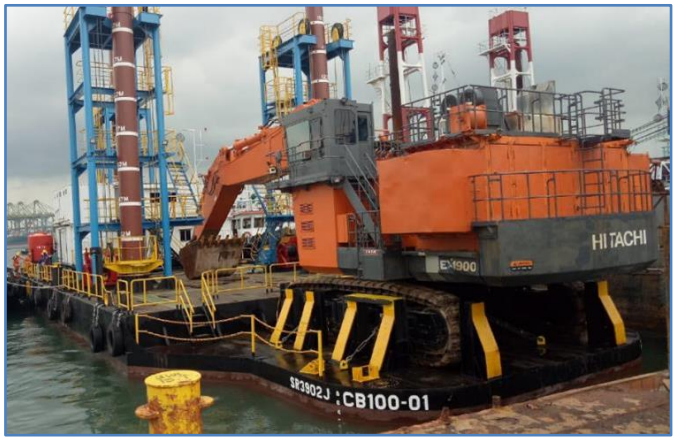

Figure 1 – (*Source:* the Operator)

DETAILS OF VESSEL 1

Name	CB100 -01 (CB)
Flag	Singapore
Classification Society	RINA
Ship Type	Pontoon[4]
Build details	2016 in PT ASL Shipyard, Indonesia
Hull type / material	Steel
Owner	Capitol Navigation Pte. Ltd.
GRT	444
Length Overall	42.06m
Depth	3.05m
Breadth	15.24m
Summer Draught | Freeboard	1.65m | 1.40m

Table 1 – (*Source:* the Operator)

[4] Non-propelled certified under Certificate of Class issued by RINA. From here onwards, the pontoon would be referred to as barge in the report. The barge carries an excavator as a cargo for its operations, to be used in dredging operations.

VIEW OF VESSEL 2

Figure 2 – (*Source:* the Operator)

DETAILS OF VESSEL 2

Name	ASL OSPREY (AO)
Flag	Singapore
Classification Society	RINA
IMO Number | Call Sign	9661493 | 9V3386
Ship Type | Bollard pull	Anchor handling tug | 73.6[5] tonnes
Build details	2012, Jiang Men Hongda Shipyard Ltd – China
Hull type / material	Steel
Owner	ASL Leo Pte Ltd
Company | Operator	ASL Offshore & Marine Pte Ltd
GRT	1714
Length Overall	54.57m
Breadth	14.95m
Depth	6.10m
Summer Draught | Freeboard	5.10m | 1.0m

Table 2 – (*Source:* the Operator)

[5] Static Bollard Pull as per the Bollard Pull Statement issued by the Classification Society.

1 FACTUAL INFORMATION

All times used in this report are ship's mean time of AO, which was five and a half hours ahead the UTC (UTC + 5.5H), unless otherwise stated.

In the conduct of marine safety investigation into the circumstances surrounding the capsizing occurrence involving the excavator barge CB under tow by AO, the investigation team reviewed information obtained from the crew of AO, the Company of AO, the Classification Society, AO's Master[6], and the company that carried out the pre-tow survey.

1.1 Sequence of events

1.1.1 On 31 March 2022, the Company of AO (hereafter referred to as the Operator) entered into a contract to tow CB from Singapore to Djibouti[7] for a dredging[8] project.

1.1.2 On 30 April 2022 a survey[9] was conducted by a marine warranty survey (MWS) company appointed by the insurer. Thereafter, on 1 May 2022 at 1355H (UTC + 8H), AO departed ASL Shipyard, Singapore, towing CB which was drawing a draught[10] of 0.8m (forward) and 1.5m (midship) with 2.2m (aft as calculated). AO's Master estimated the arrival at Djibouti to be on the 3 June 2022 at about 1600H (UTC + 3H) with the average towing speed of 5.5 knots. **Figure 3** shows the condition of the tug and tow at the time of departing Singapore.

[6] Based on the submission of the incident report. AO's Master did not respond to the investigation team's request for an interview.
[7] The passage from Singapore to Djibouti covers a total distance of about 4240nm.
[8] When on-site, the barge is made stationary and three of its spud poles are lowered to the seabed. The excavator is then used to dredge the sand. The barge does not have any other means of propulsion or maintaining its position. The spud poles are not a part of the barge's stability calculations and are additional weight.
[9] The scope was for a final MWS assessment prior to the tug and tow departing Singapore.
[10] According to the records maintained by AO, the recorded draught was 1.70m (forward) and 2.00m (aft) – Mean draught of 1.85m. The actual draughts on departure is based on the photograph, with forward and midship drafts visible, of the barge submitted by the Operator at the time of departing Singapore.

Figure 3 – The tug and tow departing ASL Shipyard with an escort tug before commencement of the tow, Singapore (*Source:* the Operator)

1.1.3 According to the passage plan[11] for the voyage, which was a part of the Towing Manual[12], the tug and tow (AO and CB) were to proceed on the planned route, (i) northwest at Malacca Straits then (ii) after passing North Sumatera westward in the Indian Ocean towards Sri Lanka, then coasting (iii) northwest along west coast of India until Mumbai, India from there they were (iv) to cross the Arabian Sea westward until Salalah, Oman at which point they would proceed (v) toward Gulf of Aden to Djibouti. See **figure 4**, indicating the approximate passage.

[11] The proposed passage plan was prepared based upon limiting the 'Open Sea' passage to minimum and ensuring that as far as feasible, the vessel is close to coastal area (land) for maximum possible duration of the Tow. If needed, subject to the behaviour of the tow and the Tug Masters' discretion, the vessel may go even further north of Mumbai area and then to attempt crossing the Arabian Sea. Source: Towing Manual.

[12] A project document for the towing of CB from Singapore to Djibouti prepared by the Operator detailing amongst others, the manning, weather forecasting, passage plan, the towing arrangement.

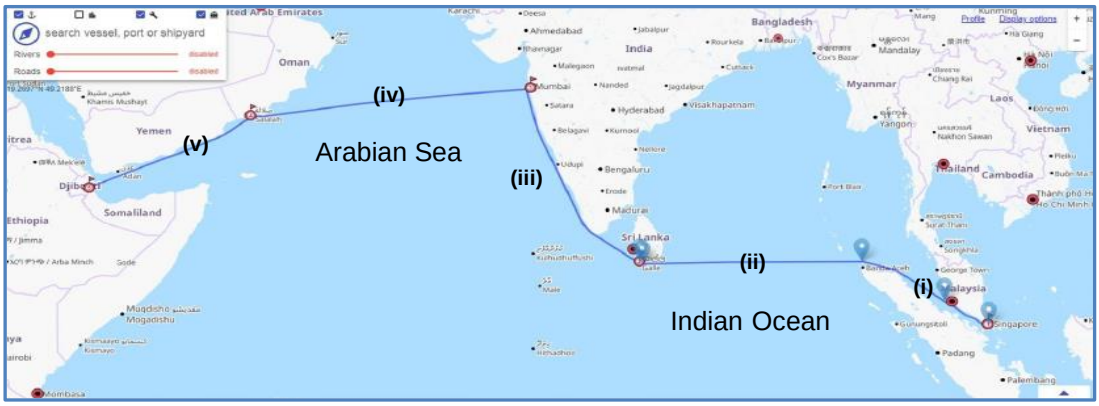

Figure 4 – The approximate planned route (*Source:* the Operator – annotated by the TSIB. Not to scale).

1.1.4 On 12 May 2022 the tug and tow were on their westerly route in the Indian Ocean towards Sri Lanka after passing North Sumatera. The length of the tow[13] at the time was recorded to be at 450m and the weather was logged as cloudy sky with south-westerly wind at speed of about 24 knots and wave height of 3.5m (BF[14] 6) with the average towing speed over 24 hours at 2.62 knots.

1.1.5 At about 0448H in position Latitude 05°55.77'N and Longitude 086°26.22'E, AO's Master noticed the starboard side spud pole missing from CB and informed the Operator of the incident. At about 1550H in position Latitude 05°54.82'N and Longitude 086°08.43'E the OOW noticed the aft spud pole was missing as well and advised the Master accordingly who in turn advised the Operator again (see **figure 5**).

[13] AO measured the length of tow using the radar's range of the signature of the tow, throughout the voyage.
[14] Beaufort Scale – e.g., BF 5: 17-21 knots. Fresh Breeze. Many white horses., BF 6: 22-27 knots. Strong breeze. Large waves begin to form; the white foam crests are more extensive everywhere., BF 7: 28-33 knots. Near gale. Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of wind.

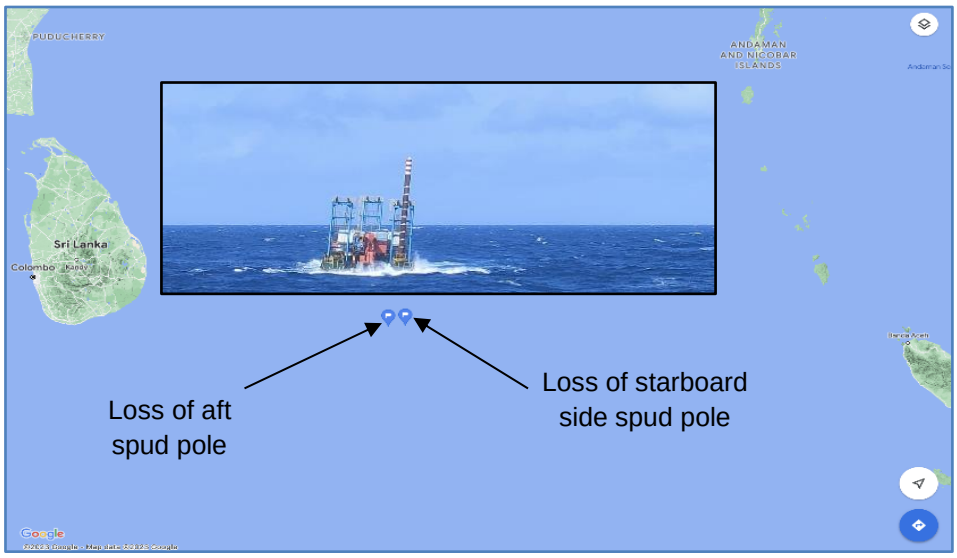

Figure 5 – View of CB's bow from AO with both spud poles missing (*Source:* the Operator – annotated by the TSIB. Not to scale)

1.1.6 The Operator advised the Master to proceed towards Galle, Sri Lanka for further instructions, and the tug and tow continued on the planned route. On 18 May 2022 at about 0800H the tug and tow arrived OPL Galle, Sri Lanka, and AO's Master shortened the length of tow to 70m and maintained the tug and tow's position while awaiting orders from the Operator.

1.1.7 On 20 May 2022 at about 1500H the tug and tow proceeded to Colombo, Sri Lanka as advised by the Operator for carrying out an inspection of the remaining spud pole and for carrying out repairs on CB, anticipating some damage to the barge. The tug and tow arrived Colombo on 21 May 2022 at about 1800H and awaited availability of a berth.

1.1.8 In Colombo, the Operator arranged for a survey[15] of the damage to CB as well as repairs[16] to be carried out and additional securing arrangements for the remaining port side spud pole. A P&I surveyor attended to CB on 2 June 2022 and 13 June 2022. After attendance by the P&I surveyor, the tug and tow departed[17] Colombo

[15] The scope was for a damage assessment after the loss of two spud poles while under tow, for insurance claims by the owner of CB. A pre-tow survey was not conducted.

[16] P&I surveyor's report provided to the investigation team by the Operator, indicated repairs were carried out on the port side, starboard side and aft spud carrier and the guard rails of CB before departing Colombo.

[17] CB's draughts recorded in the daily progress report (DPR) as submitted by AO were the same as those recorded when departing Singapore.

on 16 June 2022 at about 1700H, with the intention of proceeding on their originally planned route.

1.1.9 The weather at the time was cloudy with a maximum westerly wind forecast to be 17 knots (BF 4) along the planned route. The Master accordingly revised the estimated arrival of the tug and tow at Djibouti to be on the 7 July 2022 at about 1800H (UTC + 3H) with an average towing speed of 5 knots.

1.1.10 On 20 June 2022, the Operator noting that the tug and tow had deviated from its expected passage (and experiencing BF 6 as per the DPR), called the Master using the satellite phone followed by an email the next day, instructing the Master to revert to the planned route. The Master acknowledged the Operator's instructions and altered the heading of AO accordingly towards the planned route. On 23 June 2022, the Operator who had been monitoring AO's position, again noticed that AO's heading had changed moving away from the planned route. The Operator called the Master using the satellite phone again instructing the Master to revert to the planned route[18] but there was no change in the AO's heading (see **figure 29**).

1.1.11 On 2 July 2022 when the tug and tow was about 460nm west[19] of Mumbai, crossing the Arabian Sea westward towards Oman with the length of tow at this time recorded to be about 600m, at about 1524H the towing pennant wire rope parted[20] and was subsequently recovered onboard AO by its crew (see **figure 6**). The weather at this time was recorded to be cloudy with a westerly wind blowing at about 30 to 35 knots and wave height of 4m to 5m (BF 7). The average towing speed over the last 24 hours was about 2 knots.

[18] It could not be established whether the Operator called the Master thereafter, but the Operator informed the investigation team that they were unable to establish any communications with AO between 28 June to 2 July 2022.
[19] Approximate position Latitude 17°27.77'N and Longitude 065°00.26'E.
[20] The portion of the pennant wire rope remaining onboard AO was noted to have strands which had unravelled.

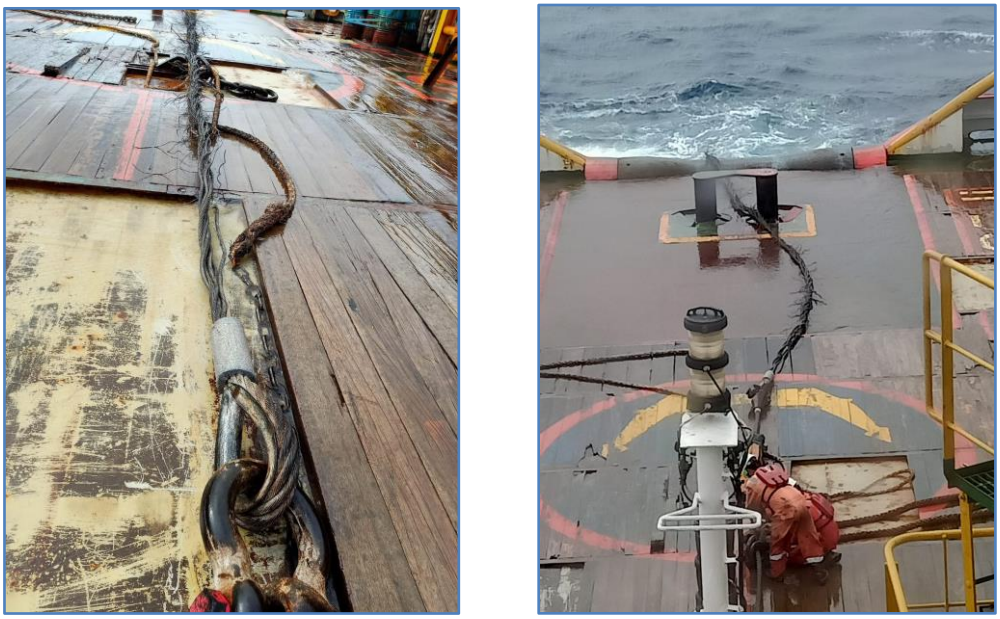

Figure 6 – The damaged towing pennant wire rope showing unravelled strands (*Source:* the Operator)

1.1.12 The Master advised the Operator at about 1535H that CB was adrift, and that AO was standing close by to monitor CB's movement (see **figure 7**).

Figure 7 – View of CB's stern as viewed from AO (*Source:* the Operator)

1.1.13 The Master attempted to connect AO to CB using the Norwegian buoy[21] but the buoy was observed to be entangled on CB. This connection was not possible, and CB was observed to be drifting towards the oilfields off Mumbai.

1.1.14 On 7 July 2022 the Master attempted to manoeuvre AO's stern towards the starboard side of CB to try to connect the tow again (see **figure 8**). At about 1230H the crew of AO were successful in connecting AO to CB using a 12-inch polypropylene rope and securing it to CB's starboard forward double bitts mooring bollards.

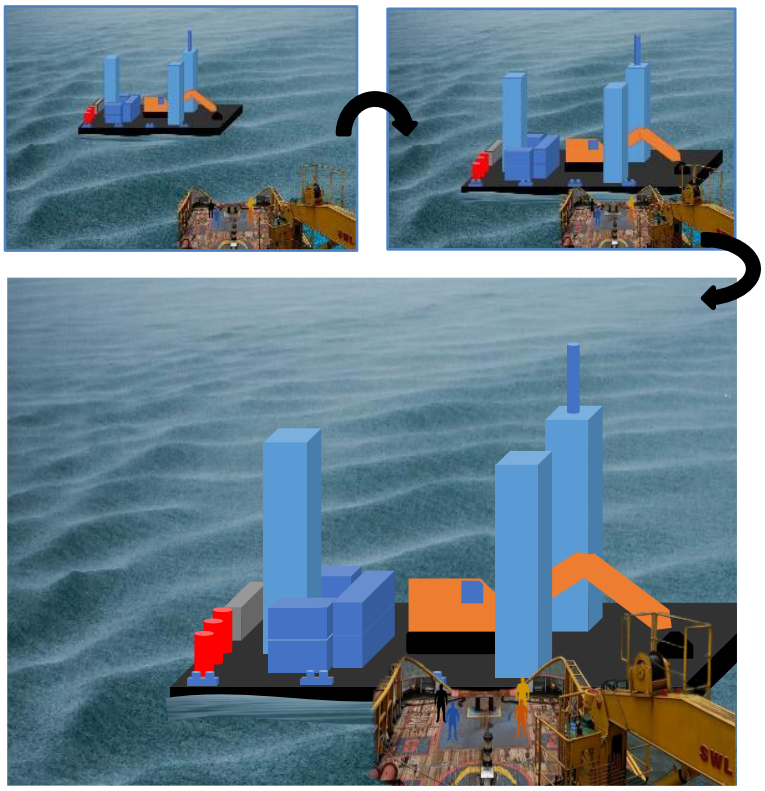

Figure 8 – AO approaching the starboard side of CB to connect (For illustration only and not to scale)

1.1.15 At about 1300H, with the length of tow at 300m, the Master was instructed by the Operator to steer AO away from Mumbai oilfields and AO proceeded at a heading of 148°. The weather at the time was BF 7 with westerly wind blowing at about 30 to 33 knots and wave height of 4m to 5.5m. At about 1600H the tug and tow were

[21] A bright coloured pick-up buoy, part of the emergency towing arrangement as elaborated in paragraphs 1.2.8 and 1.2.9.

about 230nm west of Mumbai. Around 1750H the Master noticed that CB had developed a list to starboard (see **figure 9**).

Figure 9 – CB listing to starboard as observed by AO (*Source:* the Operator)

1.1.16 About an hour later, the Master noted that CB had capsized but remained afloat. The crew of AO continued to monitor the capsized CB. On 8 July 2022 at 0658H the 12-inch polypropylene rope tow line parted at a position about 206nm west of Mumbai. The Master notified the Operator who in turn notified Mumbai MRCC at about 1505H (see **figure 10**).

Figure 10 – Capsized CB (*Source:* the Operator)

1.1.17 On 9 July 2022 at 0200H the OOW checked and confirmed by using radar[22] and visual observation of the capsized CB. At about 0231H about 186nm west[23] of Mumbai, the OOW could not observe the capsized CB on the radar. At about

[22] An acronym for **ra**dio **d**etection **a**nd **r**anging. Marine radars on ships, are used to detect other ships and land obstacles, to provide bearing and distance for collision avoidance and navigation at sea.
[23] Position Latitude 18°14.14'N and Longitude 069°43.15'E.

0658H the Master notified the Operator that CB had been lost at sea and that they were continuously searching for it.

1.1.18 On 10 July 2022 at about 0930H the search for CB was called off by the Operator and AO was instructed to proceed to Mumbai for further instructions. On 15 July 2022 the Operator received information from Mumbai MRCC that a merchant ship had sighted the capsized CB at 1540H approximately 165nm from the location where CB was lost and 93nm southwest of Mumbai.

1.1.19 On 18 July 2022, AO's P&I Club initiated the sourcing of a suitable tug that could hold CB in position. On 19 July 2022, the Operator was notified by Mumbai MRCC, that CB had washed up ashore at Palshet beach on the Indian west coast [about 291.5km south of Mumbai (see **figure 11** showing approximate locations of events)].

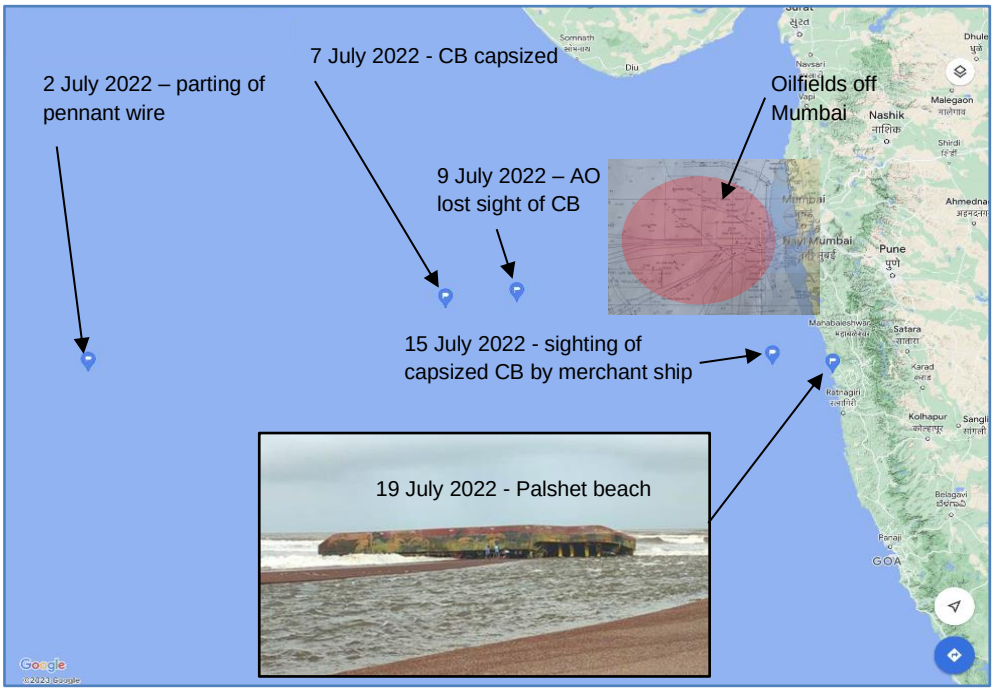

Figure 11 – Events after towing pennant wire rope parted and movement of CB (*Source:* photo by the Operator – annotated by the TSIB. Not to scale)

1.1.20 Close-up photographs of the barge's condition were provided by the Operator to the investigation team on 11 January 2023, which indicated that the hull was largely intact, with the exception of the starboard side which showed indentation in way of Frames 9 through 16 (see **figure 12**). The entirety of the hull was not

fully visible as almost a third of the hull (upper portion) was buried in the sand[24].

Figure 12 – Indentation on CB's starboard hull (*Source:* the Operator)

1.1.21 When asked, the Operator confirmed that according to the Master, during the attempt(s) to connect to CB between 5 July 2022 and 7 July 2022, CB's starboard hull made heavy contact with AO's stern and CB's hull may have been breached. A picture available to the investigation team dated 29 March 2023 indicates heavy indentation on CB's starboard hull (see **figure 13**).

[24] The Operator had engaged a company for the removal of the barge from the beach as directed by the Directorate General of Shipping, Mumbai.

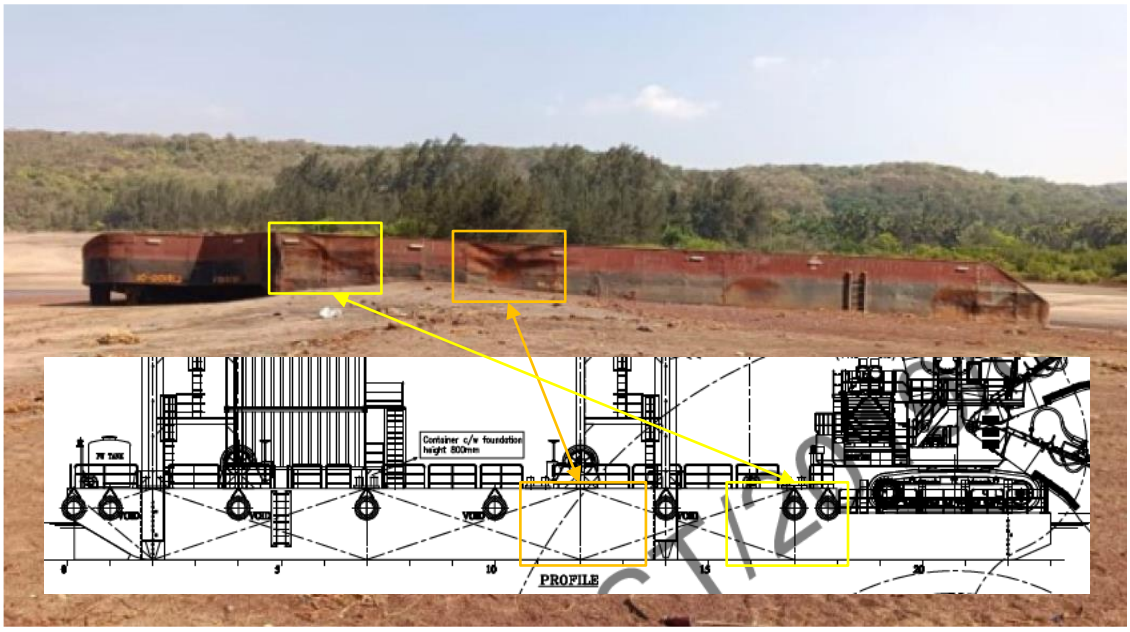

Figure 13 – Heavy indentation found on CB's starboard hull in way of Frames 11 to 13 and 16 to 18 – see annotation on General Arrangement (GA) Plan (*Source:* the P&I Club)

1.2 Description of CB

1.2.1 CB was a non-propelled work barge with an excavator unit placed at the forward part for use in dredging works. CB was fitted with three spud poles[25] erected vertically onto its tower. Two spud poles, each with its tower, were positioned on the port and starboard side forward of amidship respectively, and one spud pole with its tower positioned aft of CB's centreline.

1.2.2 CB's Intact Stability Booklet issued by the Classification Society provided a list of fittings (see **figure 14**), which were permanently welded to CB's deck and formed a part of the fixed structure of CB. The spud poles were not a part of the fittings.

[25] Each spud pole was 25.1m in length with 0.914m in diameter and weighed about 15T.

SPUD HOUSING & FITS (FWD P/S)	SEWAGE TANK	BOLLARDS
SPUD TOWER & SHEAVES (FWD P/S)	1 X 20' - GALLEY & MESSROOM L1	CHOCKS
SPUD WINCH (FWD P/S)	2 X 20' - STORE L1	SIDE ACCESS LADDERS
SPUD HOUSING & FITS (AFT)	1 X 20' - CONTROL RM & OFFICE	TYRE FENDERS
SPUD TOWER & SHEAVES (AFT)	1 X 20' - CABIN	PIPE LINES & FITTINGS
SPUD WINCH (AFT)	1 X 20' - TOILET	
HYDRAUIC POWER PACK	CONTAINER FOUNDATION	EXCAVATOR SUPPORTS SIDE
2 X GENERATORS	CONTAINER PLATFORM & LADDERS	EXCAVATOR SUPPORTS FWD
3 X 5T FW TANK (EMPTY)	MAIN MAST	EXCAVATOR SUPPORTS AFT
2 X 10000L FO TANK (EMPTY)	RAILINGS	

Figure 14 – Extract of the stability booklet of CB (*Source*: the Operator)

1.2.3 A spud carrier and winch arrangement allowed the spud pole to be raised or lowered from or onto the seabed through an opening, the spud guide, on CB's deck. When dredging, the spud poles would be lowered into the seabed to keep CB's position. Originally designed as a flat-top barge, CB was modified at the bow section from Frame 18 onwards. The breadth was reduced from 15.24m to 10.05m and the freeboard deck was lowered making the depth at the bow to be 2.0m (see **figures 15 and 16**). One set of boarding ladders[26] and four sets of double bitts mooring bollards were installed on both the port and starboard sides of CB.

[26] The boarding ladders are steel rungs welded onto the hull platting.

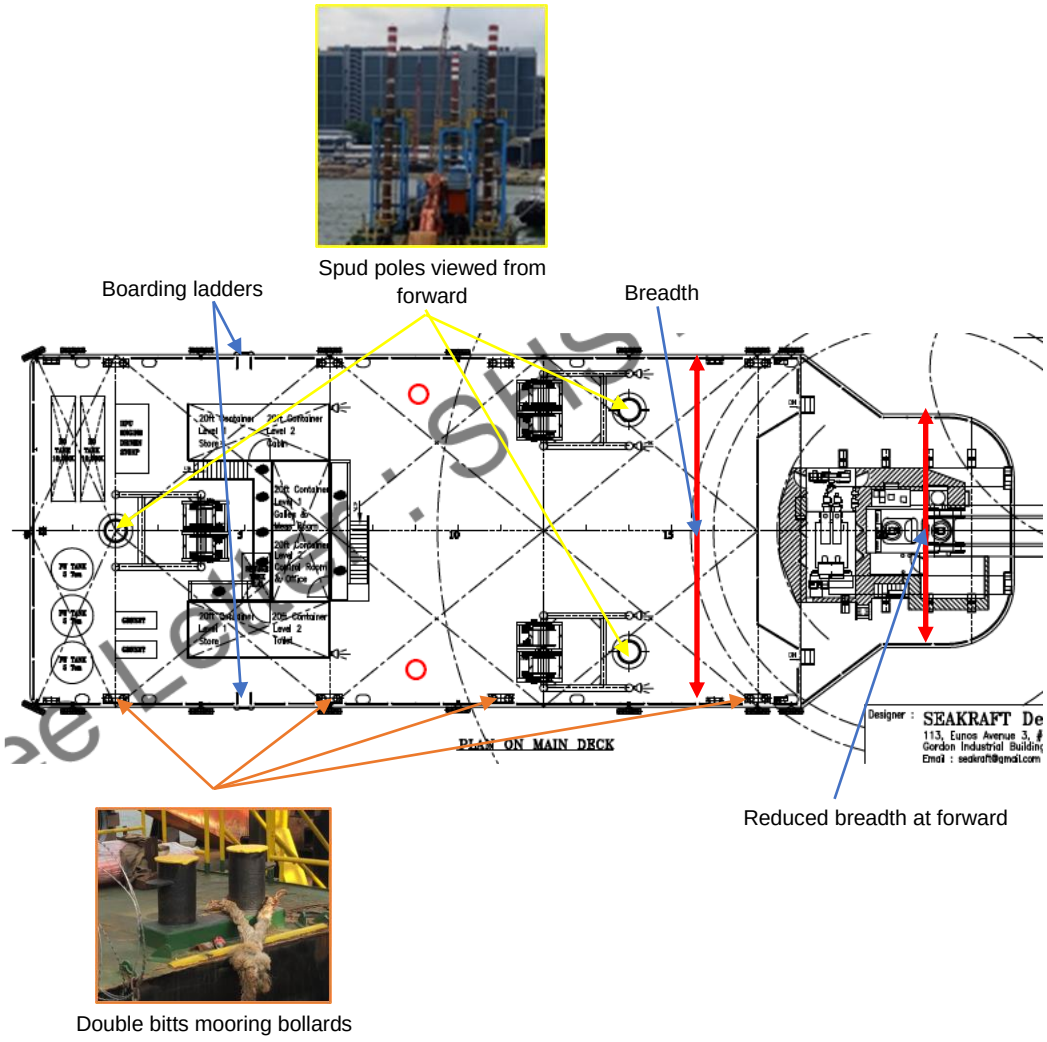

Figure 15 – Plan view of CB's GA Plan (*Source:* Operator – annotated by the TSIB)

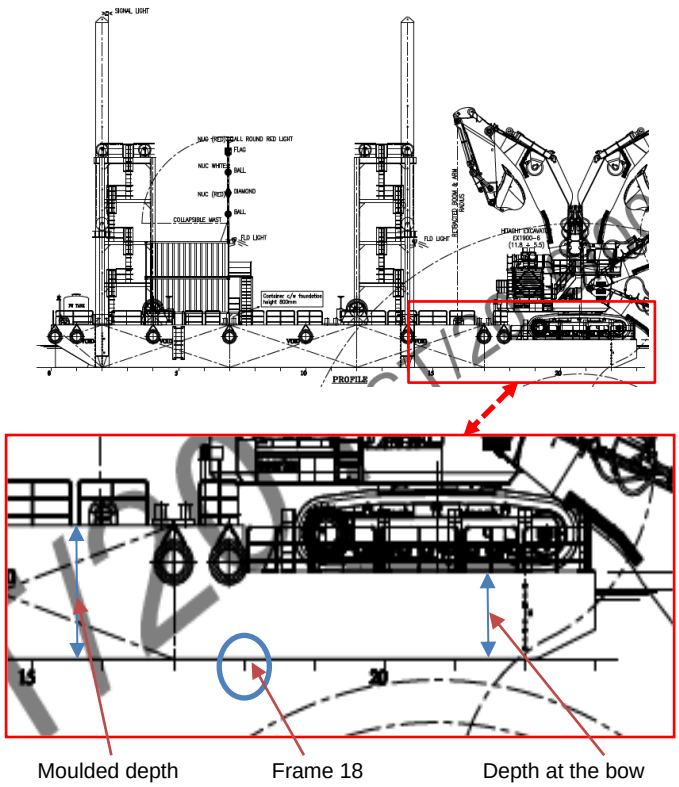

Figure 16 – Indicating the bow with depth at the bow (*Source:* the Operator – Starboard side profile view of CB GA Plan, annotated by the TSIB)

1.2.4 CB's hull was divided by one longitudinal and four transverse watertight bulkheads so forming 10 void spaces with a swim bow and stern[27]. Skegs[28] were fitted at the stern. Towing brackets[29] were fitted at the bow of the barge to facilitate towing (see **figures 17**).

[27] A design where the bow and stern section are angled towards the keel.
[28] Skegs are permanent structure located aft, a flat 'rudder like' extension of the keel. Skegs are important for directional stability especially on fully loaded barges. Barges tend to swing with no skegs, fully loaded barges may swing heavily with no skegs.
[29] Referred to as "Smit brackets" in the industry.

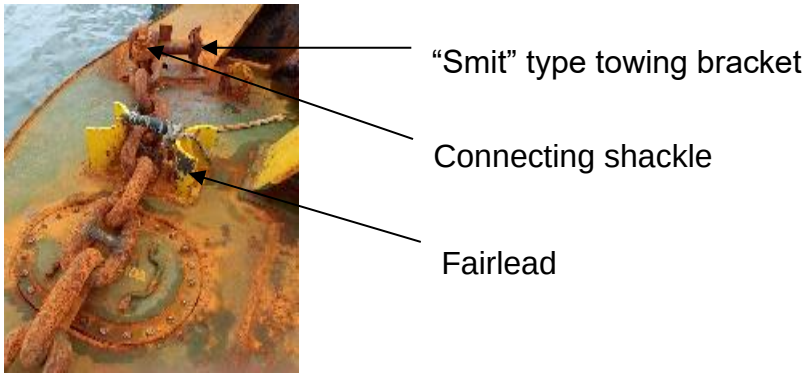

Figure 17 – "Smit" type towing bracket on the forward starboard bow (*Source:* the Operator – annotated by the TSIB)

1.2.5 As typical with most ocean-going towing voyages, CB was rigged with towing equipment provided by the Operator[30]. The main towing arrangement which comprised, in way of the chafing areas, 56mm diameter stud link chains (about 4m in length), followed by 52mm diameter bridle wire ropes of about 20m in length, subsequently 52mm diameter pennant wire rope of about 20m in length used for connection to the 875m length of a 56mm diameter main towing wire rope connected to AO (see **table 3**).

1.2.6 The main towing wire rope was of a Left-Hand Ordinary Lay (LHOL)[31], i.e., the strands of the wire are wound in counter-clockwise spiral around the core. The bridle wire ropes were connected to the pennant wire rope by a delta plate forming a bridle apex (see **figure 18**). Both the bridle wire and the pennant wire ropes were of a Right-Hand Ordinary Lay (RHOL)[32], i.e., the strands are wound in clockwise spiral around the core.

1.2.7 All chains and wire ropes were connected using shackles. The towing arrangement[33] was documented in the Towing Manual.

[30] According to the Operator, the bridle and pennant wire ropes had been supplied to AO in 2016. Records of the usage of these wire ropes between 2016 and 2021 were not available. Since July 2021 these wire ropes had reportedly been used for six towing voyages.
[31] Also referred to as Left Hand Regular Lay.
[32] This was established by the investigation team based on the photographs obtained from the Operator.
[33] Appendix G of the Towing Manual.

No.	MAIN TOWING EQUIPMENT DESCRIPTION
1	VESSEL ASL OSPREY
2	TOWING DRUM
3	MAIN TOWING WIRE SIZE:56mmx875m
4	WIRE SOCKET:56mm
5	PENNANT WIRE SIZE: 52mmx20m
6	SHACKLE SIZE:55mm
7	Delta Plate SIZE 85/55T
8	BRIDLE WIRE SIZE:52x20m
9	SMITH BRACKET WITH CHAFFING CHAIN DIA 64x4m
10	SHACKLE SIZE:55mm
11	EMERGENCY PP ROPE 12 INCH = 50m
12	EMERGENCY PP ROPE NORWEGIAN BUOY 24mm =20m
13	SHACKLE SIZE:55mm
14	WIRE SOCKET:54mm
15	EMERGENCY NORWEGIAN BUOY
16	EMERGENCY TOWING WIRE SIZE: 52mmx18m

Certificate	Date	Documented Load	Wire Lay	MBL[34]
GFC-HQ-21-06909	15 July 2021	47.29 T WLL[35]	LHOL	236.45 T
KIM EX318-2	6 April 2016	37 T SWL[36]	No info	185 T
KIM M B992	5 April 2018	49 T WLL	No info	245 T

Table 3 – Towing equipment for the tug and tow (*Source:* the Operator)

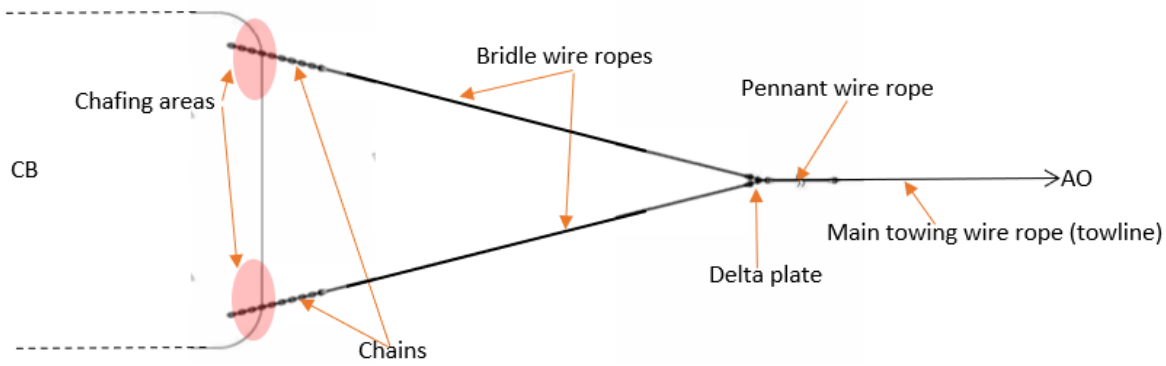

Figure 18 – Towing arrangement (not to scale) (*Source:* the Operator – annotated by the TSIB)

1.2.8 An emergency towing arrangement comprising another towing bracket at the centreline, aft of CB was connected using a shackle to another wire pennant rope of 52mm diameter and 18m in length. Attached to this pennant wire was a 12-inch polypropylene rope float line 50m in length, which was then connected to a 24mm diameter light line of 20m length connected to the Norwegian buoy (see **figure 19**).

[34] Minimum Breaking Load (MBL) in tonnes or the breaking strength is estimated around 5 times the WLL or 2.5 times the Proof Load (industry average).
[35] Working Load Limit (WLL) is the maximum working load specified by the manufacturer.
[36] Safe Working Load (SWL) an older term used to describe WLL.

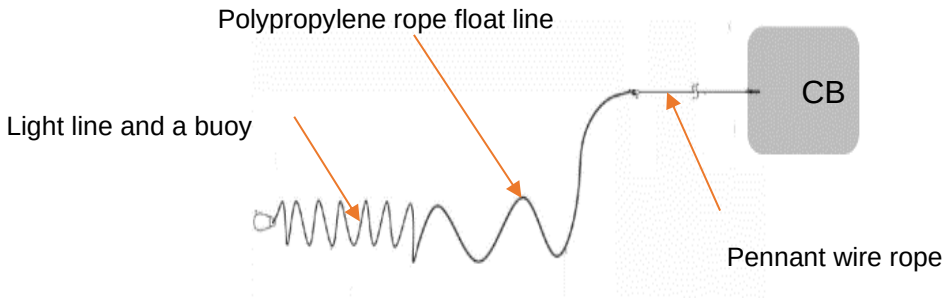

Figure 19 – The emergency towing arrangement on CB (*Source:* the Operator – *not to scale*)

1.2.9 According to the MWS company and the Operator, before departing Singapore, the emergency towing arrangement had been coiled on deck leaving the light line and Norwegian buoy in the water trailing astern of CB for retrieval in an emergency (see **figure 20**). The status of the Norwegian buoy prior to departing Colombo could not be established[37].

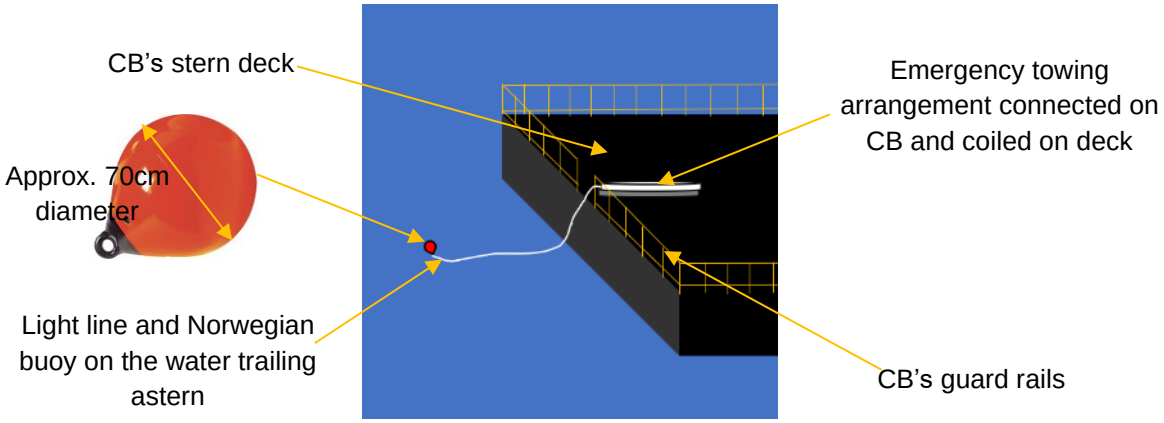

Figure 20 – The Norwegian buoy and the light line from CB (*Source:* the Operator – *not to scale* - For illustration only)

1.2.10 Six repurposed 20-foot container units were fitted at the aft of CB's deck as offices, accommodations, toilet, and storage for use by persons working when CB was operating as a dredger unit. At the stern of CB there was a fuel tank on the port side and three freshwater tanks on the starboard side. A diesel generator unit, hydraulics power unit and a sewage tank were also fitted for use during

[37] There was no MWS company survey carried out prior to departing Colombo.

dredging operations.

1.3 Description of AO

1.3.1 AO was a AHT with twin diesel engines driving a pair of controllable pitch propellers in Kort[38] nozzle. The total brake horsepower of the vessel was 6,000 (2 x 3,000bhp). All statutory certificates of AO were valid at the time of the incident.

1.3.2 AO was fitted with double drum waterfall type towing winch for the main and emergency towing wire rope with 1,000m drum capacity each (see **figure 21**).

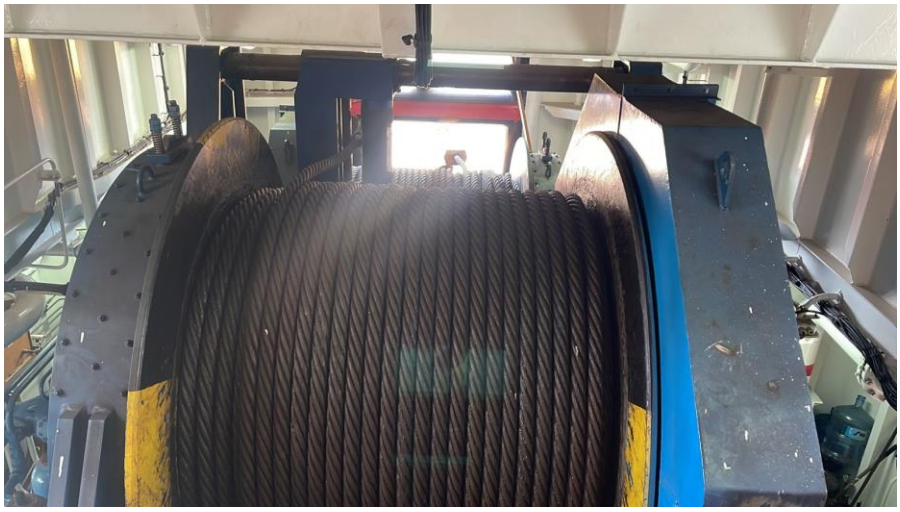

Figure 21 – Main towing wire rope on the main towing winch drum (*Source:* AO)

1.3.3 The investigation team gathered from records on AO, that at the time of the incident the maximum towing wire length onboard AO was about 836m[39]. It was further established that in 2021, the towing wire rope had been cut and the effective length was reduced from the original length (1000m) of towing wire.

1.3.4 It was also observed that when AO was not engaged in towing operation, the bridle and pennant wire ropes onboard were coiled and secured onto the ship's railing on the open deck above the towing winch compartment and covered with

[38] A ducted propeller, also known as a Kort nozzle, is a marine propeller fitted with a non-rotating nozzle.
[39] MWS used 875m in their calculations based on the information as declared by the AO.

a canvas (see example in **figure 22**).

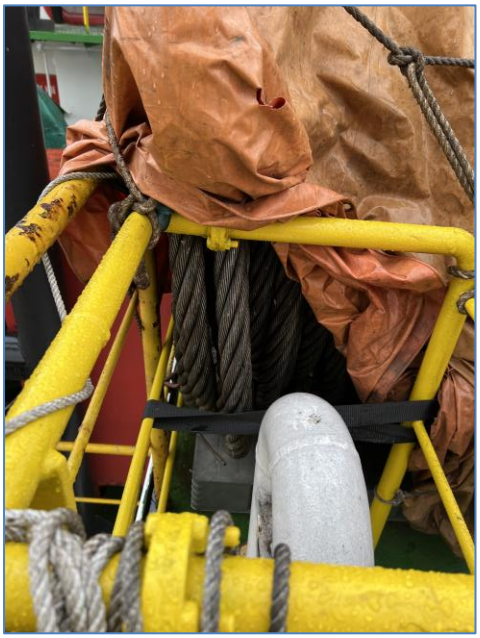

Figure 22 – Wire rope covered with canvas (*Source*: the TSIB)

1.3.5 Like most tugs of its kind, AO was designed with an open stern with a stern roller to support anchor handling and towing operations. The horn stopper on the crash rail would act as gog[40] arrangement on the towline (see **figure 23**).

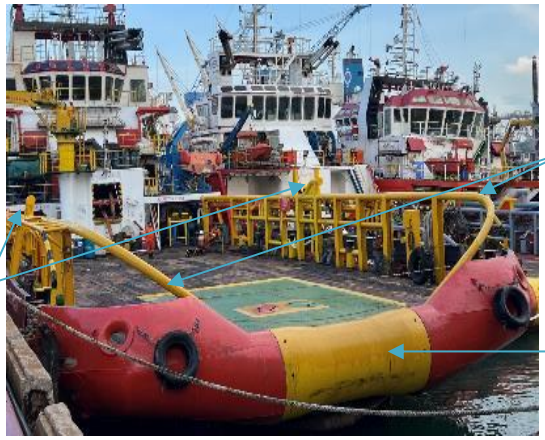

Figure 23 – AO viewed from the stern (*Source:* the TSIB)

[40] The fitting of stop used to prevent a towing wire moving onto the tug's beam. Also known as a gob arrangement.

1.4 Crew's qualifications and roster

1.4.1 AO was manned by 13 officers and crew from Indonesia. Details of relevant persons are listed in **table 4**. CB was unmanned during the towing voyage. As such there were no persons onboard CB at the time of the incident.

Rank	**Master**	**Chief Officer**	**Second Officer**
Age	35	41	34
Certificate held | Issued by	STCW Regulation II/2[41] | DGST	STCW Regulation II/2 | DGST	STCW Regulation II/2 | DGST
Daily Work hours[42]	0400H to 0800H and 1600H to 2000H	0800H to 1200H and 2000H to 2400H	2400H to 0400H and 1200H to 1600H
Experience in rank (months)	16	24	7
Experience on similar type ship (months)	48	35	13
Service with company (months)	16	24	7
Service onboard (months)	7	1	7

Table 4 – (*Source:* the Operator)

1.4.2 Prior to the towing pennant wire rope parting, the Master, Chief Officer and Second Officer's rest hour records maintained onboard indicated, in the past 24-hour, they had 16 hours of rest and in the last 7-day period, they had 112 hours of rest, indicating compliance with the STCW[43] and MLC[44] Convention, as documented.

[41] Seafarers Training, Certification and Watchkeeping (STCW) Code - A-II/2 Mandatory minimum requirements for certification of masters and chief mates on ships of 500 gross tonnage or more.
[42] Duties during watchkeeping at sea as recorded in the vessel's deck logbook.
[43] Seafarers Training, Certification and Watchkeeping (STCW) Code - A-VIII/1 Fitness for duty.
[44] Maritime Labour Convention, 2006 - Regulation 2.3 – Hours of work and hours of rest.

1.5 Seafastening[45] for the tow

1.5.1 The seafastening onboard CB for the tow from Singapore to Djibouti included securing of the excavator and the spud poles.

1.5.2 The excavator was stowed onboard against two 1.2m stanchions placed on each side, two at the front and two at the rear with the gaps between them shored up with wooden wedge. The undercarriage of the excavator was secured with wire lashings onto pad eyes welded on deck with the rear protruding engines supported by stanchions (see **figure 24**).

Figure 24 – (*Source:* the Operator – annotated by the TSIB)

1.5.3 The three spud poles were stowed vertically onto their tower. For the voyage, the hydraulic powered spud carrier was clamped onto the spud pole with the spud pole locked into position with locking pins and welded onto the spud guide with metal plate. At the top platform of the tower, I-beams[46] were welded onto the spud pole against the tower (see **figure 25**).

[45] Securing of materials or cargo onboard a vessel for sea voyage.
[46] Two outermost I-beam were the initial securing when CB departed Singapore. The photo shows the middle I-beam added in Colombo with the outermost I-beams rewelded after they had broken off during the voyage to Galle.

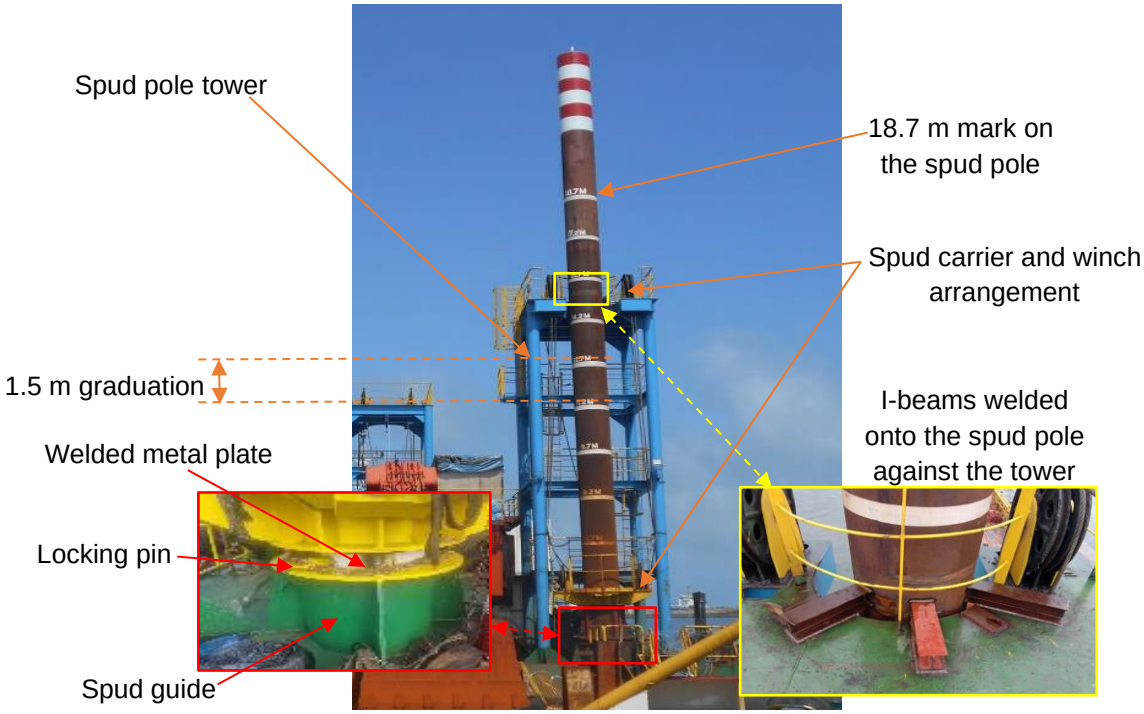

Figure 25 – Description of spud pole (*Source:* Operator – annotated by the TSIB)

1.6 Towing guidelines and the MWS company

1.6.1 The IMO's Maritime Safety Committee approved the Guidelines for safe ocean towing MSC/Circ.884 (hereafter referred to as the Guidelines[47]) to enhance safety of navigation and environmental protection for commercial towing operations.

1.6.2 The Guidelines required the conduct of a survey where the risk for towing cannot be evaluated on the basis of seafaring and nautical knowledge and experience alone. The survey should include amongst others - the towed object, including its cargo and securing arrangements and the capability to withstand the loads caused by the most adverse environmental conditions expected for the season and areas in question; the validity of the ship's certificates of the towing vessel; the suitability of the towing vessel and its towing arrangement for the particular

[47] The objectives of these guidelines are to ensure safety at sea, prevention of human injury or loss of life, avoidance of damage to the environment. The guidelines provide minimum recommendations for the organisation, planning and execution of the tow.

tow and the towed object intact stability expected during the voyage.

1.6.3 The Operator, through the underwriter, appointed a MWS company[48] to perform survey[49] of the tug AO and its tow CB for the intended voyage, covering the fitness of the tug, the tow, towing arrangement, condition survey[50], verification of crew's qualification, planned route for the voyage and weather reporting requirements.

1.6.4 For this appointment, multiple[51] visits were done which included the attendance on AO as well as CB by different surveyors each time. During the attendance a verification of the water-tight integrity of CB and the verification of seafastening were carried out.

1.6.5 Towing equipment, their condition and certificates were reportedly verified, and all certificates of CB were also verified to be valid. The MWS company carried out a towing bridle design assessment and it was determined that the design and strength of the towing equipment provided were suitable for the towage. When asked, the MWS company clarified that they were not aware that the towing wire and the towing pennant wire rope were of a different lay.

1.6.6 A towing engineering assessment was carried out to determine the 'Required Bollard Pull with limiting towing speed' and the 'Towing Bridle Design' assessment for the voyage. After calculations, which included inputs from the sets of parameters[52], the required static bollard pull of CB was determined to be 29.39MT.

1.6.7 The parameters for CB - Dimensions of CB, the type of bow, the shape coefficient for hull and the current drag coefficient of hull. The parameters for AO - the length

[48] Imprus Pte Ltd, incorporated in 2018, provides marine inspections and surveys covering marine warranties, vessel conditions and general marine surveys. They have freelance surveyors comprising Master Mariners, Marine Engineers, and Naval Architects to carry out the marine inspections and surveys. In the year 2022, they had conducted four marine warranty surveys and carried out 25 various marine surveys since inception.

[49] As per the Appendix F of the Towing Manual, the following documents were referenced by the MWS company in the conduct of the survey and assessment of the towing engineering: DNV-RP-H103, 2011, Sec 7.2.6, DNV-ST-N001 Table 11.13, ABS Rules for Building and Classing Mobile Offshore Drilling Units, 2019, C 3-1-2/1.3.2 and GL ND-0030, Guidelines for marine transportations.

[50] A condition survey would cover amongst others, the validity of the vessel Class and statutory certificates, the validity of the crew certificates, the hull and deck conditions, the lifesaving and firefighting appliances/equipment conditions, shipboard management including the safe working environment onboard, conditions of ballast tanks and void spaces, the machinery spaces conditions and the bridge navigation and communication equipment conditions.

[51] The exact number of survey attendance by the MWS company was not provided by the MWS company.

[52] The parameters as elaborated in paragraphs 1.6.7, 1.6.8 and 1.6.9 of the report.

overall, the static bollard pull and the maximum free run speed[53].

1.6.8 The parameters for cargo – the body of the excavator, its retracted boom and arm, the platform (port & starboard side combined), the accommodation and the platform aft. When asked, the MWS company confirmed, that the three spud poles were not included in this calculation[54] and determined that there was minimal windage area with the spud poles transported vertically on its platform to affect the towage.

1.6.9 The parameters for environment - the acceleration due to gravity, the density of water and the density of air; environmental parameters for stall[55] condition are wind speed, current speed, and maximum significant wave height[56]; for tow condition[57] at minimum towing speed (maximum wind speed along the tow route, maximum current speed along the tow route and maximum significant wave height and peak wave period[58]).

1.6.10 The MWS company had, through calculations of the static continuous bollard pull of AO against the towing efficiency calculations (see **figures 26 and 27** for graphical representation), further determined the effective bollard pull of AO was 42.75MT.

[53] Speed of tug without the tow object.
[54] According to the MWS company, the spud pole each yield a windage area of 10 sq.m. which is further factored down to 7 sq.m. due to shape factor of 0.7 for a cylindrical shape. This was considered by taking the platform and the spud pole as one solid block and raising the height of the block. The platforms yield an area of 37.4 sq.m. and together with the spud poles they yield an area of 45 sq.m. Because the platforms are not solid, but truss structures, the actual windage area was lesser. An additional 10 sq.m. windage area would be expected to add about 0.3T to the Total Pull Required (TPR), which would not impact on the suitability of the towing tug.
[55] The stall condition is the condition in which the barge is being helped by the tug in a given environment, without moving.
[56] The average height of the highest one-third of the waves (measured from trough to crest).
[57] The tow condition is the actual environmental condition along the tow route of the barge in a particular voyage.
[58] The wave period associated with most energetic waves in the total wave spectrum at a specific point.

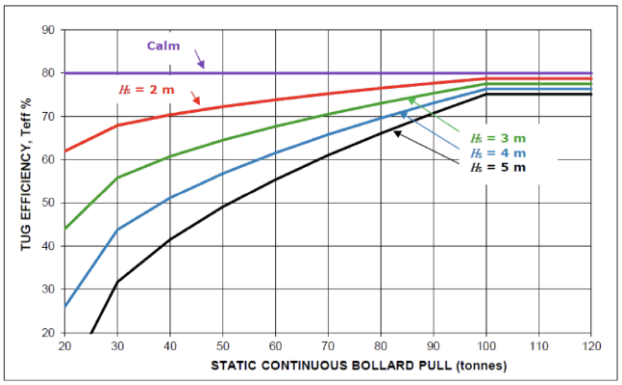

Figure 26 – Tug efficiency graph (*Source:* DNV-ST-N001[59])

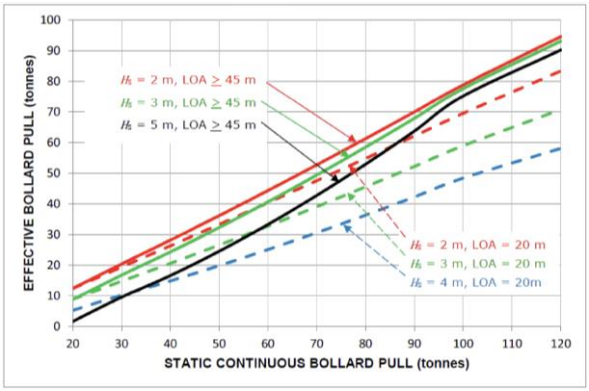

Figure 27 – Effective bollard pull graph (*Source:* DNV-ST-N001)

1.6.11 With the required static bollard pull of CB at 29.39MT and the effective bollard pull of AO at 42.75MT, from the towing engineering assessment, the MWS company determined that AO was sufficient to pull CB. The limiting towing speed for different towing environment conditions is indicated in **figure 28**.

Environment	Wind Speed (kts)	Wave Height (m)	Current Speed(kts)	Limiting Towing Speed (kts)
Environment 1	40	5	1	2.08
Environment 2	20	3	0.5	5.56
Environment 3	10	2	0.5	6.91

Figure 28 – Limiting towing speed – Appendix F of the Towing Manual (*Source:* the MWS and the Operator)

[59] Marine operations and marine warranty standards by DNV. One of the commonly used standards by the industry.

1.6.12 The investigation team noted that a bridle recovery system[60] was factored into the MWS company's bridle design assessment. There was no bridle recovery system installed onboard CB. The investigation team also noted the MWS company took the bridle apex angle[61] to be 60 degrees as a default figure in the bridle design assessment. The actual bridle apex angle for the tow was about 25 degrees. On being asked, the MWS company was not able to provide a clarification for the bridle recovery system to be factored in or for the actual bridle apex angle not to be taken for the calculations.

1.6.13 Outstanding matters were addressed by the Operator to the satisfaction of the attending surveyor prior to the issuance of the certificate of towage approval[62].

1.6.14 The certificate of towage approval issued by the MWS company was acknowledged by the Master prior to the departure of the tug and tow from Singapore. This approval included conditions of the control/risk[63] mitigation measures to be complied with during the towing voyage.

1.6.15 The relevant hazards identified by the MWS company, and their control/risk mitigation measures are indicated in the **table 5** below –

[60] A bridle recovery system should be fitted on the towed object, strong enough to be utilised after towline breakage, in case the bridle is planned to be used again during the towage, paragraph 13.12 of the Guidelines.
[61] The angle at the apex of the bridle should normally be between 45 to 60 degrees (Source: DNV-ST-N001).
[62] Referred to as the Certificate of Approval in the Towing Manual.
[63] These risk assessments were acknowledged by the AO Master.

Hazards	Effect	Control Measures
Reference to RA001[64]		
Inability of the identified tug to effectively tow the vessel in open ocean tow	Loss of tow / grounding	CB100-01 is not to be towed in weather exceeding wind/weather Beaufort 5. Operators to obtain clear weather forecasts (5-day forecast) before vessel leaves Rondo Island (Off Indonesia), before leaving Colombo Harbour (Sri Lanka) and before attempting to cross Arabian sea.
		The Passage plan to be amended such that the tug and tow are never more than 12nm from nearest land [Other than time when conducting open sea passage as per aforesaid (Bay of Bengal / Indian Ocean / Arabian Sea)]. Port of refuge at various legs of the voyage to be identified by Operator and Tug Master to understand "Over Riding Authority" as OSI[65] and has clear guidelines to cease voyage in case circumstances and weather changes.
Reference to RA003		

[64] RA001 and RA003 are Risk Assessments as attached to the Certificate of Towage Approval issued by the MWS company.
[65] On-scene in charge.

Heavy weather (sea and swell) making the towing operation unsafe leading to inability to tow	Loss of tug and tow / weather damage	Operators to ensure that there exist at least 7 days of predicted fair weather (always <BF Scale 5/6[66]) prior the tug and tow proceed on ocean tow at below points: 1) Off Sabang (Indonesia) – Off Galle: 7 days 2) Off Galle (Sri Lanka) – Off Cochin (India): 2 days 3) Off Cochin (India) – Off Mumbai (India): 5 days 4) Off Indian coast – Off Salalah (Aden): 7.5 days 5) Off Salalah (Aden) – Entry into Gulf of Aden: 5 days The above voyages to be only considered if Weather Forecast obtained shows Fair Weather (<BF Scale 5/6). In case heavy weather, sea/swell is predicted, operators in consultation with tug Master to alter/plan departure/executing the above open sea legs of the intended voyage.
Planning most appropriate voyage plan basis expected seasonal SW monsoon onset in the area	Loss of life / property	The tug and tow to be navigated safely always within 12nm from nearest land except when making open sea passages between below legs of the voyage: 1) Off Sabang (Indonesia) – Off Cochin (India) 2) Off Indian coast – Off Salalah (Aden)

[66] The MWS company and the Operator clarified, BF 6 is the limiting condition.

		3) Route plan in the Gulf of Aden corridor and approaches to Djibouti to be as per BMP 5[67] recommendations.

Table 5 – Relevant extract of hazards and control measures (*Source:* the MWS company)

[67] Publication by Witherby Publishing Group Ltd: Best Management Practices to Deter Piracy and Enhance Maritime Security in the Red Sea, Gulf of Aden, Indian Ocean and Arabian Sea.

1.6.16 As part of their control/risk mitigation measures, the MWS company also required the Master to submit a 6-hourly position report[68] via email to the MWS company.

1.7 Voyage and weather information

1.7.1 The investigation team reviewed the logbook of the AO and the DPR of the route taken by the tug and tow after the departure from Colombo till the location where the towing pennant wire rope parted and plotted the approximate positions. The positions[69] of the tug and tow and the planned route are indicated **figure 29**.

Planned route	Actual route
 *WPT are waypoint position of the planned route as per the Towing Manual	 .

No.	Date	Ship's heading in degrees (°)	Average speed in knots (kts)	Length of tow in meters (m)
1	16 June 2022	Depart Colombo		
2	17 June 2022	290	4.48	300
3	18 June 2022	290	4.66	300

[68] The last 6-hourly position report the MWS company received was on 28 June 2022.
[69] Verified with the assistance of the Operator.

4[70]	19 June 2022	290	5.14	300
5[71]	20 June 2022	290	5.07	300
6	21 June 2022	347	5.02	300
7	22 June 2022	347	5.02	300
8	23 June 2022	277	3.40	300
9	24 June 2022	277	3.05	300
10	25 June 2022	277	3.05	450
11	26 June 2022	277	3.05	450
12	27 June 2022	338	3.05	450
13	28 June 2022	270	3.75	600
14	29 June 2022	270	3.40	600
15	30 June 2022	269	3.27	600
16	1 July 2022	269	2.92	600
17	2 July 2022	Various	1.56	600

Figure 29 – Tug and tow route (*Source:* the Operator – annotated by the TSIB Not to scale)

1.7.2 The Operator provided the investigation team with a snapshot of AO's route when they became aware of the deviation from the planned route (see **figure 30**).

[70] Interpolated position based on information provided by the Operator.
[71] At position 5, the Operator called the Master indicated in para 1.1.10.

Figure 30 – Positions plotted by the Operator after receiving the DPR on 20 June 2022 (*Source:* the Operator)

1.7.3 The Operator had subscribed to a weather forecast service by DTN[72] and the weather forecast was sent daily to AO's Master, the Operator, charterer and the MWS company via email.

1.7.4 Based on the DTN forecast (showing the conditions of the expected weather, i.e., wind, sea state, currents with forecast times indicated in UTC) dated 16 June 2022, for the period 17 June till 23 June 2022, the maximum wind and sea state expected along the planned route was BF 5 (see **figure 31a**). The forecast dated 17 June 2022, for the period 18 June till 24 June 2022, indicated the maximum wind and sea state to be BF 4 along the planned route (see **figure 31b**).

[72] DTN is a weather forecast subscription service providing weather intelligence expertise with their global weather station network, delivering real-time weather intelligence.

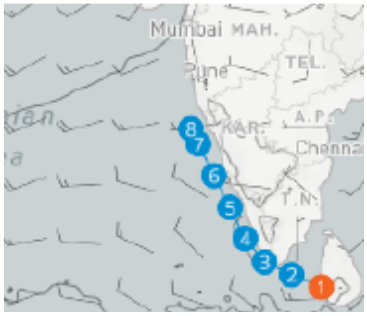	
31a – Weather forecast dated 16 June 2022 along the planned route	31b – Weather forecast dated 17 June 2022 along the planned route

Figure 31 – Weather forecast provided by DTN, which was available onboard AO (*Source*: the Operator).

1.7.5 The forecast dated 18 June 2022, for the period 19 June till 25 June 2022, indicated the maximum wind and sea state to be BF 4/5 along the planned route (see **figure 32a**). The forecast dated 19 June 2022, for the period 20 June till 26 June 2022, indicated the maximum wind and sea state to deteriorate to BF 5 along the planned route (see **figure 32b**).

	
32a – Weather forecast dated 18 June 2022 along the planned route	32b – Weather forecast dated 19 June 2022 along the planned route

Figure 32 – Weather forecast provided by DTN, which was available onboard AO (*Source*: the Operator).

1.7.6 The forecast dated 20 June 2022, for the period 21 June till 27 June 2022, took into account the deviated passage of AO, indicated the weather to be BF 6/7 along the deviated route (see **figure 33**).

Figure 33 – Weather forecast along the deviated route provided by DTN, which was available onboard AO (*Source*: the Operator).

1.7.7 The weather forecast for subsequent period 27 June till 3 July 2022 indicated the weather to worsen to BF 7 (see **figure 34**, showing the conditions of the expected weather, i.e., Wind, Waves, Currents with forecast times indicated in UTC prior to the towing pennant wire rope parting).

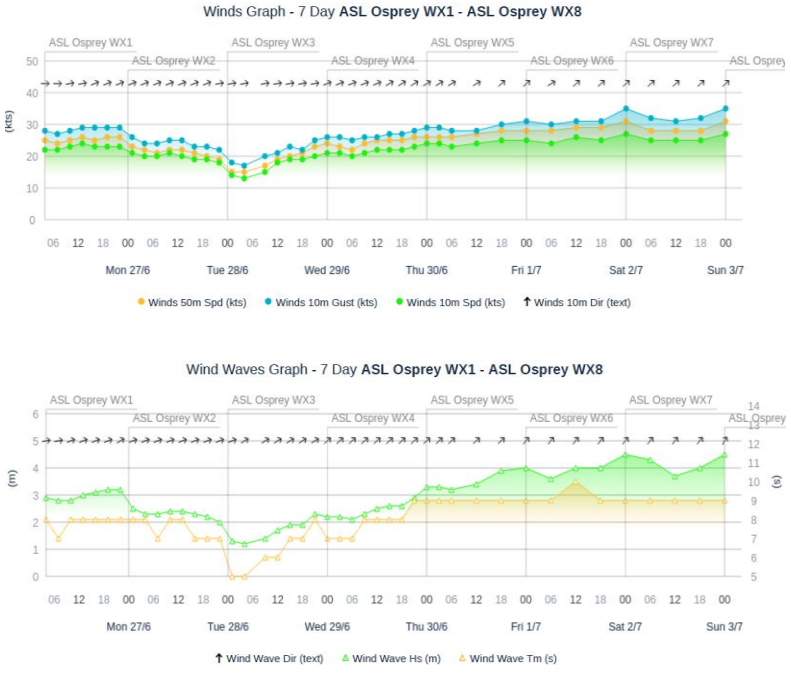

Figure 34 – Weather forecast provided by DTN, which was available onboard AO (*Source:* the Operator)

1.7.8 Preceding the loss of the aft and starboard spud poles on 12 May 2022, the Master had made visual observations of the weather which were recorded[73] in the DPR. Together with the DTN forecast, from 5 to 12 May 2022, weather conditions indicated consistent occurrences of high waves with maximum wave height at 3.5m and prevailing winds from SW with wind speed up to 25.5 knots. These are captured[74] in **figure 35**.

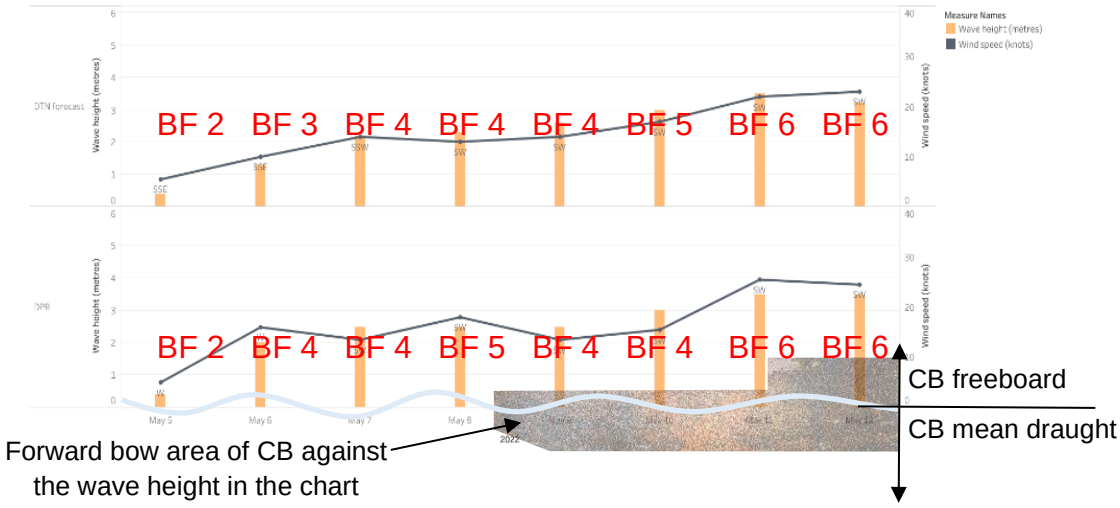

Figure 35 – Wind and waves data preceding the loss of the spud poles (*Source:* the Operator – annotated by the TSIB)

1.7.9 Preceding the break of tow on 2 July 2022, the Master made visual observations of the weather which was recorded[75] in the DPR. Together with the DTN forecast, from 25 June to 2 July 2022, weather conditions indicated consistent occurrences of high waves with maximum wave height at 5.0m and prevailing winds from WSW with wind speed up to 37 knots. These are captured in **figure 36**.

[73] Weather conditions were also recorded by the Master in his statement and the towing log.
[74] The upper graph is the DTN forecast while the lower shows the DPR data.
[75] Weather conditions were also recorded by the Master in his statement and the towing log.

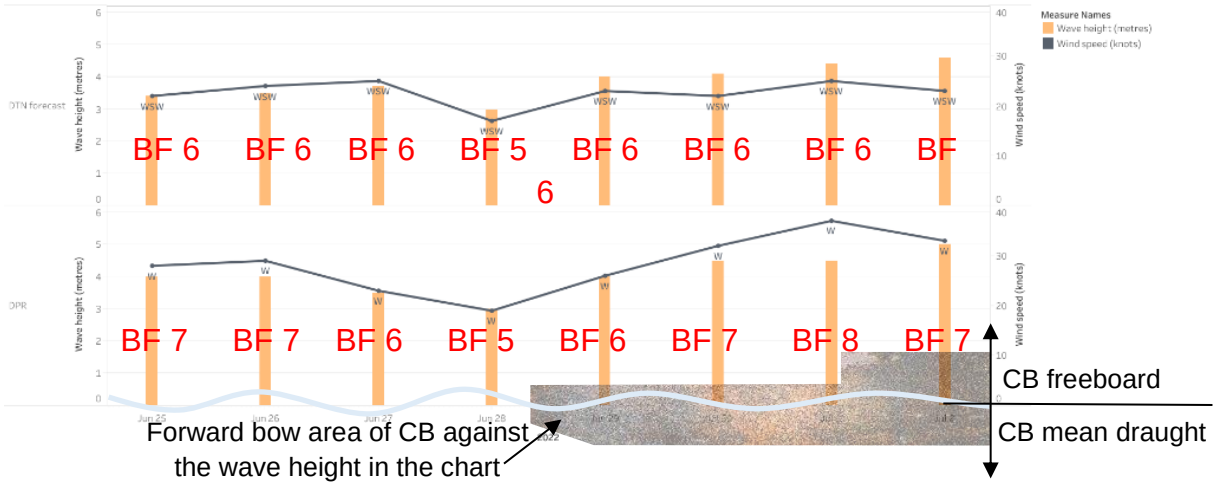

Figure 36 – Wind and waves data preceding the part of pennant wire rope (*Source:* the Operator – annotated by the TSIB)

1.7.10 Preceding the capsize of CB on 7 July 2022, the Master made visual observations of the weather and it was recorded in the DPR. Together with the DTN forecast, from 3 to 7 July 2022, weather conditions indicated consistent occurrences of high waves with maximum wave height at 5.9m and prevailing winds from SW with wind speed up to 37 knots as captured in **figure 37**.

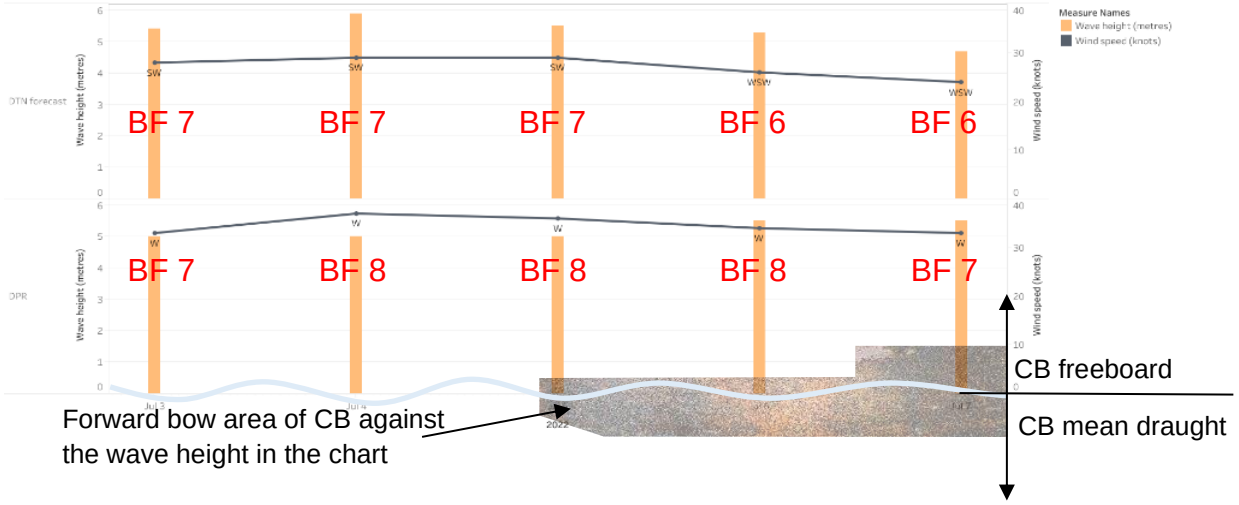

Figure 37 – Wind and waves data preceding the capsize of CB (*Source:* the Operator – annotated by the TSIB)

1.8 Additional information

1.8.1 Damage to AO

1.8.1.1 After the search for CB was called off by the Operator on 10 July 2022, AO proceeded to Mumbai. AO arrived in Mumbai on 11 July 2022 at about 1800H. The Operator had arranged for RINA surveyor's attendance onboard AO for an occasional survey after AO had sustained damage during the attempts to connect to CB.

1.8.1.2 AO had damage onto her stern area, as reported by the survey report, both the aft port and starboard bulwark had been indented and deformed (see **figure 38**).

Figure 38 – AO viewed from the stern (*Source:* Class RINA – annotated by the TSIB)

1.8.2 Operator's SMS Fleet Instruction Manual[76] and Towing Manual

1.8.2.1 The Fleet Instruction Manual – Cargo Operation (Chapter 8), provides procedures for towing operation, which includes the pre-tow planning, under tow operations, emergency situations and post-tow operations -

- Pre-tow planning – maintaining the proper crew complement and equipment pre-use inspection[77] (*sic*).

- Under tow – responsibilities of Master for the safety of the tow; maintaining of navigation, engine room and radio watch; awareness of the vessel's position, track, plot, weather and any condition which may affect the tow; reviewing weather reports at least every 12-hours; informing Master of any excessive pounding[78], rolling or shock loads to the towline[79] and twice daily inspections of the towing equipment and the watertight integrity of the towing vessel.

- Emergency situations – the office to be notified if the tug loses power; immediate attention given to personnel life-saving measures and if unable to regain control of the vessel and there is potential of loss of life or damage or loss of the vessel, then distress and salvage procedures will be in effect.

- Post-tow operations – all towing equipment will be recovered, cleaned, inspected, oiled as required and properly stowed upon completion of the tow.

1.8.2.2 According to this section, the tow arrangement plan must be approved by the operation manager or the marine superintendent before commencement of any tow. The investigation team was not able to determine whether there was any such approval prior to the commencement of the tow.

1.8.2.3 The Operator was not able to provide any records of towing equipment cleaned, inspected, and oiled upon completion of the tow for the previous towing

[76] Fleet Instruction Manual – Cargo Operation is Chapter 8 of the Company Safety Management System (SMS) which comprised 11 chapters.
[77] Interpreted as inspection of equipment prior its use.
[78] The investigation team's query, the Operator confirmed that the text should read – "the Master is to inform the office"
[79] All wire rope pennants shall have hard eyes or sockets and be of the same lay (i.e., left or right hand) as the main towline – DNV-ST-N001 standards.

voyages (see **table 6**). Similarly, no pre-use inspection records were available for the towing equipment.

Towing voyages	Voyage 1 – Lumut to Terengganu[80]	Voyage 2 – Lumut to Terengganu	Voyage 3 – Terengganu to Johor
Month/Year	July 2021	September 2021	October 2021
Duration	6 days	6 days	3 days
Towing voyages	Voyage 4 – Batam, Indonesia to Ras Al-Khaimah, UAE	Voyage 5 – Qatar to Batam, Indonesia	Voyage 6 – Kemaman to Batam, Indonesia
Month/Year	October 2021	January 2022	April 2022
Duration	30 days	40 days	4 days

Table 6 – Historical voyages with the use of the same towing gear (*Source:* the Operator)

1.8.2.4 The Towing Manual detailed the responsibilities of the Operator, the client[81] and the MWS company. Amongst others, the Operator was responsible for the preparation of the Towing Manual, the client was to ensure that the tow has the required towing equipment prior to sail away and the MWS company was responsible for the issuance[82] of the Certificate of Towage Approval.

1.8.3 CB's tonnage certificate

1.8.3.1 The original tonnage measurement was on 23 April 2016. Based on a re-measurement on 31 May 2019 in Batam, the certificate was reissued due to change of flag and modification work to the barge.

1.8.3.2 The new certificate indicated the moulded draught to be 2.39m. The Classification Society has since amended the draught in the certificate

[80] Lumut, Terengganu, Johor and Kemaman are in west peninsular Malaysia.
[81] The hirer or charterer of the tug and tow.
[82] The Operator and the client are jointly responsible for obtaining the Certificate of Towage Approval.

accordingly to 1.65m.

2 ANALYSIS

2.1 The voyage and prevaling weather conditions

2.1.1 The Towing Manual and the conditions of control and risk mitigation measures set by the MWS company (as per table 5) for the voyage to be undertaken by AO were acknowledged by the Master before the tug and tow departed Singapore.

2.1.2 According to these conditions, the barge was not to be towed in weather exceeding BF 5 and for a 5-day forecast to be obtained at various points in the voyage. A Port of Refuge was also recommended to be identified for various legs of the voyage.

2.1.3 After rounding off Sumatera, the forecast indicated that the weather was expected to be BF 5/6 and the tow proceeded as planned, given that BF 6 was the limiting condition.

2.1.4 When the tug and tow were on a westerly route towards Sri Lanka, the weather deteriorated progressively from BF 4 to BF 6 (see **figure 35**) and two spud poles were noted to be missing (discussed later) from CB. The nearest Port of Refuge was Colombo (Sri Lanka) and the tug and tow proceeded accordingly at the instructions of the Operator for a further assessment.

2.1.5 Additional lashing and securing arrangements were then made at Colombo which extended into the month of June 2022, i.e., a delay of almost a month before the tug and tow could resume its voyage towards Djibouti.

2.1.6 The planned route approved for the towing manual after WPT 23 (on departure from Colombo) was for AO to proceed along the western coast of India until WPT 25 (see **figure 29**) where the weather conditions were forecast to be within the criteria specified by the MWS company in their control and risk mitigation measures criteria given the seasonal monsoon periods expected in or around the month of June (see para 1.1.9).

2.1.7 The conditions of control and risk mitigation measures further stipulated that the tug and tow were to proceed within 12nm of the nearest land unless performing an open-sea passage (see RA001 in table 5) and for the Master to exercise his “Over Riding Authority” should the circumstances change. On noting that AO was not proceeding on the planned route, the Operator called AO instructing the

Master to revert to the planned route. The investigation team noted that the Master reverted towards the planned route briefly, but again deviated, after which the AO became uncontactable till 2 July 2022.

2.1.8 The investigation team was unable to determine the reasons why the Master deviated from the planned route to commence an early crossing of the Arabian Sea, after departing Colombo instead of proceeding close to the Indian coast until Mumbai.

2.1.9 Correlating the weather forecast along the planned route, the investigation team opined that there was no valid justification for the Master to have deviated early. On the contrary, the deviated passage took the tug and tow into a worsening weather condition, which may have had an adverse effect (increase in strain) on the towing arrangement.

2.2 Parting of the towing pennant wire rope and its condition

2.2.1 AO and CB were in sea state BF 7 when the towing pennant wire rope parted causing CB to be adrift. It is likely that the towline experienced an increased strain under the prevailing conditions. It is an accepted practice to pay out the main towline when encountering heavy weather to reduce the tension experienced on the towing arrangement.

2.2.2 The towing equipment was checked by the MWS company together with the crew of AO, prior to issuance of the certificate of towage approval and there were no reports of any abnormalities in the condition of the towing arrangement.

2.2.3 The length of the main towline onboard AO was 836m which was shorter than the certified length of 1000m. The MWS company had taken the length of towline into its calculations based on what was provided by AO. At the time of the incident, the length of the towline in use was about 600m making it stiffer during the tow. Although the maximum available length was 836m, the reasons for the towline not to be paid out further by the Master of AO, could not be established by the investigation team, as doing so could have reduced the tension on the towing arrangement.

2.2.4 The investigation team noted that the small bridle apex angle could have resulted

in an increased sway[83] motion of CB during the tow which in the prevailing heavy weather conditions, contributed to the strain on the towing arrangement.

2.2.5 The investigation team noted that the towing pennant wire rope was of a different lay to the main towline. It was evident that this combination had been used in the past six voyages (since 2021), with the longest one being 40 days. Although the Operator had specific procedures for towing equipment to be inspected pre-use and recovered, cleaned, inspected and oiled post-tow operations there was no evidence that this had been carried out.

2.2.6 The portion of the towing pennant wire rope recovered onboard AO showed signs of a wire rope being “unravelled or unwound” (see **figure 6**). The investigation team considered the probability that the use of wires of two different lay could have had an impact on the towing pennant wire rope after being subject to regular strain during the preceding voyages and the incident voyage.

2.2.7 When not being used for towing operation, the towing pennant wire rope was stored on an open deck area of the AO and covered with a canvas. In the absence of any pre-use inspection records, the condition of the towing pennant wire rope since it had been supplied onboard could not be determined. However, the likelihood of it being exposed to corroding factors[84] when not in use, existed.

2.2.8 The weather experienced at the first leg of the voyage, i.e., before Colombo when the spud poles were lost and subsequently after departing Colombo (BF 7) likely resulted in the towing pennant wire rope to unwind after experiencing strain over a period of time, which got exacerbated during bad weather, causing it to further weaken and eventually part.

2.3 The loss of tow and its capsize

2.3.1 When AO’s towing pennant wire rope parted, the tug and tow were about 460nm from the coast of Mumbai and about 350nm from the oilfields.

2.3.2 CB was not fitted with a bridle recovery system which would have enabled a connection to be made. Although an emergency towing arrangement was provided at the aft of CB, which had a Norwegian buoy (allowing for a connection

[83] The linear transverse (port-starboard) motion.
[84] Sea water, rain, chemicals, and solvents, etc.

to be made), connection to this was not successful as the buoy was noted to be entangled on CB. According to the MWS company, the Norwegian buoy was deployed when the tug and tow departed Singapore.

2.3.3 The investigation team considered two possibilities, i.e., the Norwegian buoy was not deployed prior to departing Colombo or it had been deployed but got entangled enroute in the weather conditions experienced by the vessel.

2.3.4 None of the crew could confirm that the Norwegian buoy had been deployed after the additional repairs (for seafastening) conducted on CB in Colombo. There was no arrangement made by the Operator for a pre-tow survey to be conducted to verify whether the tug and tow complied with the conditions of the MWS company, including verification of the towing equipment and the emergency towing arrangement.

2.3.5 There was a high probability that the emergency towing arrangement on CB had not been verified for the subsequent leg of the voyage. As such the Norwegian buoy was not available to facilitate a connection to CB.

2.3.6 To prevent the barge to drift towards the oilfields off Mumbai, the Master of AO then attempted to connect the CB using ropes on the barge's starboard side where the double bitts were located and in view of the prevailing weather conditions. In this attempt, AO reportedly contacted the CB in the process of making a connection which was successful. The consequence of this contact was not apparent to the Master of AO at the time, however, within five to six hours of making this connection and commencing the tow towards Mumbai, CB was seen to develop a starboard list and capsize.

2.3.7 It was twelve hours later after the capsize that the connecting rope parted, and CB went out of sight (presumably sunk) before being washed up ashore 206nm away.

2.3.8 The investigation team assessed whether the cargo onboard CB had shifted when the weather deteriorated. The CB had a mean freeboard of only about 1.55m. With waves of 3.5m or higher, the investigation team noted the likelihood that green water(seas) being washed over the deck of CB during the tow, which could potentially cause damage to the equipment on deck. There was no observation of the CB developing a list before the AO's contact with the barge. Noting the additional seafastening in Colombo, it was unlikely that the cargo could have

shifted, causing the barge to list. However, it would have been prudent, given the low freeboard, for the CB to have been transported on a heavy lift transportation vessel.

2.3.9 Correlating the damage sustained at the stern roller of the AO (see **figure 38**) and the indentations noted on the barge (on Palshet beach – see **figure 13**), it was highly likely that during the attempt to connect to CB, its hull may have been breached. The hull breach would have likely compromised its watertight integrity causing seawater ingress which may have been limited to the starboard compartments in way of Fr. 11 to 13 and 16 to 18 (see **figure 13**). This partial ingress allowed the barge to float below the sea surface and being eventually washed ashore.

2.4 Loss of spud pole(s)

2.4.1 During the damage survey at Colombo, it was evident that two I-beams welded (see **figure 25**) prior departure Singapore had dislodged and together with the failure of the spud carrier clamp and locking pins, two out of three spud poles were lost. The dislodging and the failures were likely caused when CB was subjected to the motions[85] in sea state BF 6.

2.4.2 Although it was determined that the transport of the spud poles would not have impacted the towage, the investigation team considered the possibility that the forces experienced by the spud poles (stowed vertically) in a towing voyage may be higher in various degrees of motion. The investigation team noted that the two spud poles broke free of their securing and fell into the sea through the spud guide and thus, the securing of the spud poles in Singapore was deemed inadequate.

2.4.3 It would have been prudent for an engineering assessment to be conducted on the spud poles, and any cargo onboard, to ensure that they are adequately secured prior to the voyage and to consider horizontal stowage of the spud poles.

[85] A ship at sea experience six degrees of motion: heave, sway, surge, roll, pitch, and yaw.

3 CONCLUSIONS

From the information gathered, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

3.1 A marine warranty survey was conducted prior to AO's departure from Singapore which included inspection and verification of towing arrangement. There were no abnormalities found. A risk assessment was also conducted prior to the issuance of the certificate of towage approval.

3.2 According to the conditions of control and risk mitigation measures, the tug and tow were not to proceed in weather conditions beyond BF 6 and to seek a port of refuge should the circumstances change. In addition, non open sea passage was to be conducted within 12nm of the nearest land.

3.3 When AO encountered bad weather (BF 6) after Sumatera, two spud poles were lost from CB. As a result, AO proceeded to Colombo for repairs and additional seafastening as instructed, which delayed the voyage by one month. On departure from Colombo, the planned route, which took into consideration the weather forecast and the criteria specified by the MWS company required the AO to proceed towards Mumbai before crossing the Arabian Sea.

3.4 Despite having access to a 7-day weather forecast the AO's Master deviated from the planned route early without a valid justification. This deviation took the tug and tow into a weather of worsening condition of BF 7 causing additional strain on the towing arrangement.

3.5 Although there was an additional of 200m of towing wire length available for the Master to payout when the weather deteriorated, this was not done to reduce the tension on the towing arrangement.

3.6 The small bridle angle could have resulted in an increased sway motion of CB during the tow. The lay of the towing pennant wire rope and the main towline were different, which likely resulted in the the towing pennant wire rope to unwind. A combination of these factors had likely contributed to the towing pennant wire

rope to weaken over a period of time and eventually part in the prevailing weather conditions.

3.7 Before the tug and tow departed Colombo, there was no survey conducted to verify the conditions by the MWS company, such as the emergency towing arrangement (Norwegian buoy). In the absence of the bridle recovery system and a Norwegian buoy the AO was not able to make a suitable connection to CB.

3.8 As a result the AO's Master attempted to connect to CB at the starboard side in the prevailing weather conditions. Although the connection was successful, during that process AO's stern roller breached CB's hull compromising its watertight integrity, and subsequently capsize. The breach likely resulted seawater ingress into the barge causing it to float below the sea surface and wash up ashore.

3.9 The loss of spud poles from CB was a result of inadequate seafastening which did not withstand the various degrees of motion and forces experienced by the spud poles (stowed vertically) when CB was subjected to a sea state of BF 6.

3.10 The towing pennant wire rope had been covered with a canvas and stowed on deck when not in use. It was evident that the Operator's SMS had not been implemented to ensure that the towing equipment was inspected before and after use. The actual condition of the towing equipment was thus likely not known.

4 SAFETY ACTIONS

During the course of the investigation and through the discussions with the investigation team, the following safety actions were initiated by the relevant stakeholders

4.1 Actions taken by the Operator

4.1.1 As part of the Pre-mobilisation and Pre-departure checks to document the towed vessel condition prior departure, Masters are required to provide evidence on the deployment of the Norwegian buoy.

4.1.2 A fleet wide check on all the tugs towing gear setup to confirm that the towing wires were either LHOL or RHOL options.

4.1.3 Improving the monitoring and reporting process for vessels that are heading towards areas where bad weather is expected with a 6 hours and 4 hours reporting. Additionally, the vessels are being tracked by satellite tracking system to ensure effective monitoring and immediate reporting of deviations from agreed voyage plans.

5 SAFETY RECOMMENDATIONS

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

It is recommended that the Operator:

5.1 Requires the conduct of an engineering assessment when determining seafastening arrangements for carriage of spud poles, or any cargo, being towed. **[TSIB Recommendation RM-2023-03]**

5.2 Ensures its SMS requires the conduct of a pre-tow survey for verification of conditions of the certificate of towage approval when there is a change in circumstances during the voyage. **[TSIB Recommendation RM-2023-04]**

5.3 Reviews its SMS so as to ensure accountability and responsibility for inspection and maintenance of towing equipment. **[TSIB Recommendation RM-2023-05]**

It is recommended that the MWS company:

5.4 Reviews its weather limiting conditions for approving a tow which has a bridle apex angle of less than 45 degrees. **[TSIB Recommendation RM-2023-06]**

-End of Report-